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February 7, 1995

Hand Delivered

Mr. Phil Justus
Staff Geologist
U.S. Nuclear Regulatory Commission
Mail Stop T7-C6
Washington, D.C. 20555

RE: December 16, 1994 NRC Facsimile Request for Surface Subsidence Information at Moab Salt Cane Creek Potash Mine and Comments on Possible Subsidence Studies at Atlas Minerals Uranium Tailings, near Moab Utah.

Dear Mr. Justus:

After contact with Mr. Wayne Hedberg of the Utah Division of Oil, Gas and Mining (DOGM) and Mr. Rick York, manager of the Moab Salt Inc. Cane Creek Potash mine, I have collected several documents regarding the topic of surface subsidence in the vicinity of the potash mine which is located about 8 air-miles downriver from the Atlas Mill Tailings site.

Enclosed you will find the following documents:

1. "Report Evaluation of Subsidence Potential Above Cane Creek Potash Mine Near Moab, Utah" by Schnabel Engineering Associates, dated August 2, 1989.

2. DOGM Memorandum from Scott Johnson to Holland Shepard, regarding subsidence monitoring, dated September 7, 1989.

3. Moab Salt Inc. letter from C. Alan Tapp to Lowell Braxton and Holland Shepard of DOGM, regarding Subsidence Report, dated September 25, 1989.

4. Schnabel Engineering Associates letter to C. Alan Tapp regarding September 7, 1989 DOGM comments and additional subsidence analyses, dated September 20, 1989.

These documents discuss evaluations made to estimate future surface subsidence, if the underground mine opening were to collapse. References are also provided in the attached August 2, 1989 Schnabel Engineering report that document the plastic behavior of the Paradox Salt Formation, encountered during construction and operation of the underground mine. This same report quotes closure rates of the underground mine opening that approach 2 inches/year, although I have heard anecdotal information from Moab Salt mine personnel of episodes of much greater closure rates in certain areas of the mine.

Telephone conversations with Mr. York at the Cane Creek Mine have confirmed my previous recollection of a contour map of past subsidence at the mine. However, as of date Mr. York has been unable to locate this map. Schnabel Engineering indicates that the consultant had no knowledge of any existing subsidence monitoring network at the Cane Creek Mine, and that previous elevation measurements made at well heads at the mine may have been unreliable (September 20, 1989 Schnabel Engineering letter, p. 4). Regardless, if Moab Salt is able to locate the subsidence contour map I will in turn pass it on to you.

Commentary on Moab Salt Subsidence Calculations

After further thought on the matter of subsidence, I don't believe that the Moab Salt analysis can be considered a direct corollary to the Atlas site in that the subsidence mechanics and geometry are different than those at the Cane Creek mine. At the Atlas mill tailings, surface subsidence would be caused primarily by passive dissolution of the underlying Paradox Salt Formation by ground water flowing into the Colorado River. At the Cane Creek mine, the surface subsidence would be caused by the collapse of the walls of the mine into the underground cavity.

The geometry at the Atlas site is also different than the Cane Creek scenario in that the surface collapse will be initiated at a few hundred feet; whereas the cavity of the Cane Creek mine is found at a depth of about 3,000 ft below ground surface (see Schnabel Engineering submittal of September 20, 1989, Figures 2 and 3). This greater depth at Cane Creek provides opportunity for "bridging" or dissipation of the subsidence by the overlying strata which will minimize the magnitude of the collapse that may be reflected at the ground surface. At the Atlas site, the surface collapse will be initiated at a depth of a few hundred feet, near the contact between the Paradox Salt Formation and the overlying sedimentary bedrock and/or unconsolidated materials. As a result, the magnitude of the subsidence at depth will be reflected to a greater degree at the ground surface at the Atlas site.

In addition, it has been reported that depth of the geologic contact of the Paradox Salt with overlying bedrock and/or alluvium is poorly defined at the Atlas site. NRC staff have reported that discontinuous soils logs in a single boring indicate that it may be found at a depth of about 400 feet near the center of the Atlas site. The subsidence mechanics and geometry considerations mentioned above reinforce the need to accurately determine the depth of the Paradox Salt contact at the Atlas Mill Tailings facility.

Possibility of Need for Additional Subsidence Studies at Atlas Site

Most of the geology related discussion during our December 13, 1994 meeting focused on the issues of capable faults and seismicity for the Atlas site. Since that time and after discussion with the Utah Geologic Survey (UGS), it appears that the issue of subsidence at the Atlas site also deserves some additional consideration. While we agree that subsidence information may be gathered from the trenches Atlas has recently proposed on the north side of the tailings pond to explore for capable faults, additional studies may also be needed south of the tailings in order to assess the full potential of local subsidence. This need for this possible additional study grows out of the following considerations:

1. Total Apparent Subsidence in Moab Valley - based on discussions with UGS staff it appears that the alluvium is thickest near the center of Moab Valley, at a point south of the Atlas site. Combined with the topographic low now found in the Moab Slough, this suggests that past subsidence has been greater adjacent to and south of the Colorado River. Considering past migration of the Colorado River, it may be possible that past subsidence was greater south of the tailings embankment rather than north of it.

2. Conventional Alluvial Fan Geometry - based on conventional alluvial fan geometry, we expect that the alluvial material at the mouths of Moab and Courthouse Washes is thickest on the distal end of the fans down near the Colorado River. As a result, exploration work along the south side of the tailings embankment may have more success locating marker beds in the subsurface than explorations on the proximal end of the fans, north of the embankment.

Possible Studies to Estimate Future Subsidence at the Atlas Mill Tailings Facility

There are three methods that could be used to estimate the potential subsidence at the Atlas site, which we offer for further discussion:

1. Subsurface Trench Studies - trenching studies of the alluvial materials at the site may locate marker beds that may demonstrate evidence of past subsidence, which could be used to estimate future subsidence at the site. These types of studies would be most useful if the marker horizons found in the trenches consisted of indicator ash beds or contained organic materials that could be radiocarbon dated. These type of studies may be combined with the trenching planned by Atlas on the north-side of the tailings pond to assess the capable fault issue. However, if such marker beds or organic radiocarbon material cannot be found, additional studies will need to be conducted in order to assess the potential of future long-term subsidence at the site. Trenching studies along the south-side of the tailings impoundment would likely be more indicative of the total subsidence at the site in that the alluvial wedge likely thickens from north to south under the site. However, trenching south of the tailings impoundment may be impractical due

to the high water table in that area. As a result, we expect that subsurface borings would be the most practical technique to employ in this area, see discussion below.

2. Subsurface Boring Studies - continuous soil borings could be used to evaluate past and estimate future subsidence at the Atlas site. This would involve soil coring and lithologic logging to determine the maximum depth extent of alluvial deposits and the location of the bedrock contacts at the site. Because the Colorado River is known to be degrading or down-cutting thru its watershed, all alluvial fan materials found in the subsurface below the elevation of the current river bed are the result of past subsidence at the site, and not the product of fluvial deposition by the river. The measurement of the total depth of the alluvial materials would then constitute the maximum subsidence experienced at the site in the past.

   In addition, if marker ash beds or organic radiocarbon could be located in these soil borings, this material could be used to estimate the rate of the subsidence at the site. We expect that the possibility to find organic material in the subsurface would be greatest in low-lying areas or near the current wetlands, i.e., in the Moab Slough area or perhaps between the tailings embankment and the Colorado River. Due to the differing hydrogeologic conditions north and south of the Colorado River, and the resultant ground water related dissolution, perhaps both of these areas should be studied in order to determine the range of possible subsidence in the vicinity of the tailings embankment.

3. Mass Balance Studies - based on the current understanding of local geology and salt tectonics which have effected the region, we expect that the majority of future surface subsidence at the tailings embankment will be in response to dissolution of the underlying Paradox Salt Formation by flowing ground water. Reportedly the aquifer under the Atlas site has been found to be chemically stratified, as demonstrated by a freshwater zone which overlays a deeper layer of saline ground water. This deeper saline ground water represents active dissolution of the Paradox Salt Formation. We expect that further study will find that the interface between these two layers of ground water will be represented by a thin zone instead of a sharp interface. Diffusion of salt across this mixing zone would represent a removal mechanism for salt to the Colorado River. In addition, if the lower layer of saline ground water has a direct point of discharge to the river, perhaps at a very slow rate at some downstream location, this would also represent another mechanism for salt removal to the Colorado River.

   If the ground water flow regime for both the fresh and saline ground waters were well defined, the advective velocities of the ground water and the removal rate of the salt from the Paradox Formation could be estimated. Once normalized across the area of study or at a minimum across a ground water flow system stream tube, these removal rates of salt could be used to estimate the maximum subsidence that could be expected in the future.

Of course, this approach would be based on the assumption that current climatic conditions continue in the future.

We agree with the general phased approach we discussed in our December 13, 1994 meeting which will allow the issues of capable faults and seismicity to be explored first. We would hope that at the conclusions of those studies that an assessment be taken of the surface subsidence issues and additional work effort planned and executed as necessary.

We appreciate the opportunity to work with you regarding evaluation of the Atlas Uranium Mill Tailings reclamation project. If you have any other questions or comments regarding the attached documents or our comments on possible approaches to the required subsidence studies listed above, please feel free to call me at (801) 536-4250.

Sincerely,

Loren B. Morton, Hydrogeologist
Division of Radiation Control

Enclosures

LBM:lm

cc: Gary Christenson, UGS
Mike Ross, UGS
Wayne Hedberg, DOGM
Rick York, Moab Salt, Inc.

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